Acoustical Aspects of Chamber Music for Strings

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Abstract: Playing string quartet music under different room acoustics conditions demands adaptation of the playing technique. To determine the reactions of the musicians to the boundary conditions as well as the listeners' impressions, a test was performed by playing the same program of short and characteristic music examples during only three hours in three halls having different acoustic properties. The corresponding acoustical criteria of rooms and instruments like reverberation versus decay time or early reflections versus attack times are discussed.

INTRODUCTION

It is an old experience that there exists a clear influence of the room acoustic boundaries on the sound impression of the audience listening to a musical performance. Musicians know this effect, and many players try to adapt their playing technique to the room acoustics, but some chamber music ensembles prefer to perform their interpretation at all times in the same way ignoring the room acoustic effects. In order to find out in which way musicians (and listeners too) react on different room acoustic situations, a test was performed with the string quartet of the author: during a time of less than three hours, the same program was played for the same audience, but in three different halls. For the audience, this performance was mainly intended as a pure demonstration, only some experienced listeners have been asked later about their impressions. But the players discussed extensively about their impressions and experiences during the rehearsals and the performance taken place in the three halls.

THE TEST PROGRAM

The program of the performance consisted of three separate movements taken from well-known string quartets and having quite different musical character, but these movements corresponded together in such a way that it was possible to play one after another without only a short break. These pieces were:

1. Introduction of Jos. Haydn's „Seven words of Jesus Christ”, op. 51. This piece has an obvious sacral character, blocks of chords alternate with lyric passages, great dynamic contrasts and rests play an important role. From the acoustical point of view, this piece lives on the spatial sound of the room.

2. Finale of Jos. Haydn's string quartet „The Lark”, op. 64 No. 5. This piece is characterized by very fast semiquaver figures of the first violin combined with unobtrusive accompaniment, in the middle part of the piece, the four voices correspond in a contrapuntal manner. This movement demands a high degree of clarity for the very short notes (duration about 130 ms), the dynamics are confined to the fine structure of the musical lines.

3. Finale of W. A. Mozart's string quartet D major, K 575. In this movement, all four voices participate in the musical structure having nearly equal rights. Permanent changes of motives as well as superpositions of several parts demand a good balance between the four voices and a high clarity of the ensemble sound.

ACOUSTIC PROPERTIES OF ROOMS AND INSTRUMENTS

Fig. 1 shows the ground plans of the three halls used (from left to right in the temporal order of the test). The auditorium has a volume of about 1500 m³, the height of the ceiling differs from 5.3 m above the podium to 3 m at the rear end. Whereas the ceiling is a plane reflecting area, the side walls are more or less absorbing. The concert room of the Schimmel piano factory has a volume of 800 m³, the height of the ceiling is about 4 m. Side walls as well as the ceiling are reflecting (more or less diffusely), the rear wall is absorbing. The hall of the museum is constructed as a roofed inner court with an absorbing canopy in the middle part (height 8.5 m); the outer parts of the ceiling ascend up to 11 m. The volume of this hall lies about 3000 m³. Whereas in two halls, the audience was concentrated on one side of the players, in the museum, the listeners were distributed around the ensemble.

Fig. 2 compares the reverberation time of the halls (occupied by the 80 persons who followed the performance by bus) with the 60 dB decay time of the string instruments. The hatched area represents the typical values for fingered notes, if the bow does not damp the decay (playing „off the string”). These decay times are relevant for all types of string instruments corresponding to their compass. If the bow remains „on the string”, the decay times are reduced to values down to about 0.1 s. Open circles represent the decay times of open strings: in this case, there is a clear difference between the values for violas and violins (about 3 s) in contrast to the double basses and cellos.
(between 5 and 10 s). As to be seen from the hatched area, „usual“ (i.e. fingered) tones of the higher strings need little reverberation support by the room for sounding not too dry. This may be effected by a frequency-balanced reverberation time in the order of 1 s (like Schimmel hall). The descending reverberation curve of the auditorium may affect positively the volume of the lower voices, but adversely the higher voices as well as the brilliance of all voices. The long reverberation of the museum dominates strongly over the sound decay of the string instruments.

![Fig. 1](image-url) ground plans of the halls used for the test (dark areas: audience)  
![Fig. 2](image-url) RT of the halls and decay time of string instruments (hatched areas: fingered tones, circles: open strings)

**EXPERIENCES OF PLAYERS AND LISTENERS**

By the players, the Schimmel hall was felt as the best one for mutual hearing as well as for ease of the instruments’ speaking. The reverberation seemed to be adequate for all three pieces and enabled a full ensemble sound, though particularly the cello player preferred the little longer reverberation time occurring during the rehearsal. Nevertheless all examples could be played with the „original“ tempo as studied previously.

In the auditorium, the players could realize a full ensemble sound too, even if the reverberation time was shorter. But difficulties arose when a single voice had to play without accompaniment; those notes had to be played little louder „than normally“ and in particular very „dense“ (i.e. without tonal gaps). In soloistic passages, the player missed the reaction of the room which was to dry, therefore the fast notes of the Lark quartett demanded a little slower tempo than studied as the speaking of the violin was little impaired because of a lack of early reflections. Though the reverberation during the rests between separated chords seemed (for the players!) to be sufficient.

In the museum, the long reverberation enabled a little slower tempo for the „Introduction“: the room supported a very rich and full sound, but the players were surprised, that the reverberation between the chords seemed to be solved from the instrumental sound without any possibility of influence by the players. The sixteenth notes of the Lark quartett could be played in the fast „original“ tempo, as the player had the impression of a good speaking of his instrument, but even for the other players, these notes appeared to much slurred instead of sounding separated. The polyphonic structure of the Mozart movement demanded much more visual contact between the players than in the other halls, as there did not exist any early reflections. This effect made it very difficult to realize sufficiently synchronized rubati or ritardandi. Furthermore it was necessary to enhance the articulation of the single tones, for example by „striking“ the bow for a sharp accentuation of trills.

By the audience again, the Schimmel hall was evaluated the best. All listeners praised the homogeneous sound being full as well as transparent, even if some listeners would have preferred a little longer reverberation. In the auditorium, the judgement of the audience was divided into two groups: listeners sitting more or less close to the ensemble felt the sound impression being rather good whereas listeners in the rear part of the room criticized the very „long“ and dry rests between the chords, furthermore they were surprised how clear all noise components and even very little inaccuracies became audible. In the museum, the long reverberation was felt as disturbing, not as supporting the string quartett sound, as there was no connection between direct sound and spatial sound of the hall. Only the chords followed by rests were praised because of their full sound.

**CONCLUSION**

The experiment confirms, that in halls with unsufficient acoustic properties, these boundaries should be regarded when arranging the program, and furthermore, that early reflections for the players should be generated by use of mobile elements erected on the podium in a distance of only few meters from the players.